PART TWO

SUBSURFACE DRAINAGE

CHAPTER 3

SUBSURFACE DRAINAGE REQUIREMENTS

3-1. General.

a. Usage requirements. Soil and ground water conditions may make necessary the installation of subsurface drainage systems in selected areas. Subsurface drain systems must be completed in their entirety within the 180-day mobilization construction period. Where subsurface drains are necessary, independent outlets or outlets free from backwater effects will be provided. The system's durability should insure a 5-year life with a minimum of maintenance. The selection of material is to consider potential deterioration from corrosion and abrasion, which could include seepage from an occasional spill of industrial wastes or petroleum products. Concrete pipe should be avoided where the pH of the soil or in the fluid carried is expected to be below 5.5 or above 9.0 for extended periods of time.

b. Criteria application. For the most part, criteria for subsurface drains apply equally to airfields, roads, and railroads. There are certain details of airfield complex systems design however, that require manholes, observation basins, and risers for access which are not necessary for simpler, smaller subsurface drainage systems associated with roads or railroads. Such structures should only be used where well justified from a maintenance standpoint for a limited 5-year duration.

3-2. Investigations to determine subsurface drainage requirements. For the satisfactory design of a subsurface drainage system, the determination of the subsurface soil and water conditions is a prerequisite. The field explorations and borings made in connection with the project design should include the following investigations pertinent to subsurface drainage.

a. Soil conditions. The soil conditions investigated for other purposes in connection with the design will supply a large amount of information that can be used for the design of the drainage system. It may be advisable to supplement these explorations at locations of subsurface drainage structures and in areas where soil information from a drainage viewpoint is incomplete. All soil investigations should be coordinated into one program. Soils investigation from former construction in the area may be used to supplement the exploration or when no other information is available.

b. Ground water. The location and depth of permanent and perched ground water can also be obtained from the soils investigation test holes. In many locations, information may be obtained from residents of the surrounding area regarding the behavior of wells and springs and other evidences of subsurface water.

c. Photogrammetry. The analysis of aerial photographs of the areas selected for construction may furnish valuable information on general soil and ground water conditions. Aerial photographs exist for almost the entire United States, taken for the Agricultural Adjustment Administration, the United States Forest Service, the Soil Conservation Service, and the Topographic Branch of the United States Geological Survey. The Map Information Office of the latter organization maintains records of available United States photographic coverage of all agencies. An aerial photograph presents a graphic record of the extent, boundaries, and surface features of soil patterns occurring at the surface of the ground. The surface features of the soil are the surficial evidence of the characteristics and behavior of subsurface materials. The presence of vegetation, the slopes of a valley, the colorless monotony of sand plains, the farming patterns, the drainage pattern, gullies, eroded lands, and evidences of the works of man are revealed in detail by aerial photographs. The use of aerial photographs may supplement both the detail and knowledge gained in the topographic survey and ground explorations. The sampling and exploratory work can be made more rapid and effective after analysis of aerial photographs has developed the general soil features.

d. Soils tests. The major amount of information required for the subsurface drainage design can be obtained from the soils investigation with a minimum of laboratory tests. Soils information from other investigations in the area should also be used. The final selected soil properties for design purposes should be expressed as a range, one extreme representing the best average maximum value and the other the best average minimum value. The true value should lie between these two extremes but may approach or equal one or the other, depending upon variation within a defined soil stratum. The perviousness of a given soil, or its ability to conduct water, is measured by the coefficient of permeability. It is expressed as the rate of flow for a hydraulic gradient of one through a unit area of soil. The coefficient of permeability of some soils is difficult to determine and requires experienced and skilled personnel.

3-3. Criteria for determining the need for subsurface drainage. Subsurface drainage may be divided into base drainage, which consists of removing water from a base course beneath a pavement; subgrade drainage, which consists of removing water from the subgrade beneath a pavement; and intercepting drainage, which consists of collecting and removing water found flowing in pervious strata or from springs.

a. Base drainage. Base drainage is required where frost action occurs in the subgrade beneath the pavement. Frost action is assumed to occur in all frost-susceptible subgrades. Base drainage is also required where the ground water rises to the bottom of the base course as a result of either natural conditions, ponding of surface runoff, or consolidation of soil under the weight of the base course. At locations where the pavement may become inundated, and there is little possibility of water draining from the base into the subgrade, base drainage may be required. As a guide to determining where base drainage is required in cases of inundation, the following tabulation may be used.

Depth to ground water (feet):	Base drainage required if subgrade coefficient of permeability is smaller than (fpm)
Less than 8	1×10^{-5}
8 to 25	1×10^{-6}
More than 25	1×10^{-7}

Where subgrade soils vary greatly in coefficient of permeability with depth, judgment should be exercised in determining the necessity for base drainage. Base drainage is also required at the low point of longitudinal grades in excess of 2 percent except where the subgrade coefficient of permeability is 1×10^{-3} or greater.

b. Subgrade drainage. Subgrade drainage is required at locations where seasonal fluctuations of ground water may be expected to rise in the subgrade beneath a paved area to less than 1 foot below the bottom of the base course.

c. Intercepting drainage. Intercepting drainage is required where seeping water in a pervious stratum will raise the ground water table locally to a depth of less than 1 foot below the bottom of the base course. This flowing water may be found in thin pervious soil layers, in exposed rock cuts, or as seepage from springs.